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ABSTRACT

A series of seven experiments provided information on the relationship between the learning of prose and the structural importance of the linguistic subunits. Five samples of prose, including narrative folktales and two samples of textual prose, were studied to determine whether the patterning of learning corresponded to the structural importance of the respective verbal units. In this series, an objective method was devised for dividing complex verbal materials into linguistic subunits possessing psychological significance. The learners in Experiments I and II attempted a single verbatim reproduction of a narrative folktale either immediately after reading the folktale or after a seven-day retention interval. Two textual selections were studied in Experiments III and IV and their structural importance rated. Experiment V was conducted to determine whether the relationship between structural importance and recall resulted from learners adopting a learning strategy in which more learning time was allocated to more important units. In Experiments VI and VII, a determination was made of the role of structural importance in the serial learning of linguistic subunits. From a methodological viewpoint, two of the techniques used possess the potential of having wide applicability to the analysis of text. These are: (1) the technique of segmenting prose according to locations of pausal acceptability, and (2) the technique whereby linguistic subunits within a prose passage may be hierarchically ordered. (Author/CK)

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A SERIES OF EXPERIMENTS CONCERNING THE RELATIONSHIP BETWEEN LEARNING AND THE STRUCTURAL PROPERTIES OF LINGUISTIC SUBUNITS

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A Series of Experiments Concerning the Relationship Between Learning and the Structural Importance of Linguistic Subunits

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Summary

A series of seven experiments provided information on the relationship between the learning of prose and the structural importance of the linguistic subunits. Five samples of prose, including three narrative folktales and two samples of textual prose, were studied to determine whether the patterning of learning corresponded to the structural importance of the respective verbal units. In addition, an examination was made of the role of meaningfulness in the learning of linguistic subunits within textbook passages.

In the present series of experiments, an objective method was devised for dividing complex verbal materials into linguistic subunits possessing psychological significance. The samples of prose were segmented into linguistic subunits at the junctions which were psychologically acceptable for pausing. An objective method was then used to calibrate the individual verbal units according to their structural importance and meaningfulness within the prose passages. In particular, the hierarchical orderings of the linguistic subunits was determined by having raters eliminate a specified portion of the prose passage according to the characteristic being rated. The final step was to relate the calibrations of structural importance and meaningfulness to the actual recall of the units. The strategy used in the present studies thus was to divide prose passages into smaller units, to measure the structural importance and meaningfulness of the units, and to determine whether the ratings of the units were related to recall.

The 267 learners of Experiments I and II attempted a single verbatim reproduction of a narrative folktale either immediately after reading the folktale or after a seven-day retention interval. An independent sample of 99 raters provided data on the structural importance of the units. In both experiments, the structural importance of the units was found to be strongly related to the recall of units.

Two textual selections were studied in Experiments III and IV. The structural importance of the textbook passages was rated by 99 college students. A second sample of 96 raters judged the meaningfulness of the units. Another group of 48 raters made predictions as to which units would be remembered. Four separate groups of college students, ranging in size from 46 to 61, attempted a single verbatim reproduction immediately after reading the textual passage or after a retention interval of one week. The patternings of recall were significantly related to structural importance, meaningfulness, and predicted recall. Meaningfulness was directly related to recall, but the relationships between structural importance and recall were curvilinear.

Experiment V was conducted to determine whether the relationship between structural importance and recall resulted from learners adopting

a learning strategy in which more learning time was allocated to the more important units. Despite a presentation procedure which limited each linguistic unit to an exposure interval which was sufficient only for a single reading of that unit, there was still a strong relationship between structural importance and recall. The relationship was evident both for the 57 learners attempting an immediate reproduction and also for the sample of 48 learners attempting a reproduction after seven days.

In the final two experiments of the series, a determination was made of the role of structural importance in the serial learning of linguistic subunits. The learners in Experiment VI were permitted to control the exposure rates of the verbal units. In Experiment VII, the presentation rates of the units were controlled automatically. The 40 learners in each of the two experiments received three serial anticipation trials. Regardless of the method of controlling the presentation rates, a strong relationship existed between the structural importance of the units and their remembering.

Overall, the present series of experiments have demonstrated the generality of the relationship between structural importance and recall. A relationship existed for narrative prose as well as for textual prose. In addition, the relationship was evident at immediate as well as at delayed retention intervals. The relationship was not dependent upon a particular method of presenting the linguistic units. Regardless of the experimental variations, a substantial relationship was found between structural importance and recall.

Similarly, the meaningfulness of the linguistic units in textual prose was shown to be closely related to remembering. Meaningfulness is evidently as important a determinant of the learning of prose as it is of the learning of isolated verbal units in lists.

From a methodological viewpoint, two of the techniques used in the present studies possess the potential of having wide applicability to the analysis of text. First, the technique of segmenting prose according to locations of pausal acceptability has marked advantages over the subjective judgements which have been used in previous studies. Second, the technique whereby linguistic subunits within a prose passage may be hierarchically ordered is potentially relevant to any rating dimension.

Introduction

Background of Problem. Researchers interested in studying the learning of complex verbal materials, such as connected discourse, have been unable to advance knowledge much beyond the principles delineated by Bartlett some 35 years ago. Despite great interest in the principles governing the learning of textual narrative, complex verbal passages are seldom used as learning materials. A major reason that previous experimenters have used nonsense syllables and lists of words, rather than words in context, as in prose, lies in the fact that measurement methods have been developed for calibrating the meaningfulness of the isolated unit. Furthermore, the calibrations of meaningfulness of the isolated units accurately predict rates of learning.

In contrast, comparable methods are not available to Es interested in studying the principles governing the learning and retention of verbal narrative. Cloze procedures and readability formulas have permitted comparisons between larger segments of prose, but methods are not available for sub-categorizing linguistic units within a prose passage. Levitt (1956) has shown that there is little agreement as to what the linguistic subunits are, and little agreement as to the importance of the subunits.

In an earlier series of experiments (Johnson, 1968), an objective method was devised for dividing complex verbal materials into linguistic subunits possessing psychological significance. Secondly, an objective method was used in calibrating individual verbal units according to their structural importance in a prose passage. Finally, the calibrations of the structural importance of the individual linguistic units were related to the actual learning and retention of the verbal units.

In the previous series of studies, student raters divided a 330-word folktale into "pausal acceptability" units. Raters were told that the functions served by pausing might be to catch a breath, to give emphasis to the story, or to enhance meaning. The 66 locations in the story which were psychologically acceptable for pausing were thus hypothesized to be one of the functional boundaries used in encoding and decoding the narrative. A copy of the folktale, divided into pausal acceptability units, may be seen in Appendix A.

The selection of "pauses" as possible boundaries for learners' segmentation of meaningful discourse is obliquely supported by several experiments. For both normal hesitations (Goldman-Eisler, 1958; Martin, 1967; Martin & Strange, 1968; and Tannenbaum, Williams, & Hillier, 1965) and for stuttering (Taylor, 1966), pauses preceded words which were less predictable than other words uttered in fluent contexts. The greater frequency of pausing was associated with longer

words, with content words, and with earlier words of speech units. The literature thus suggests that pauses may be viewed as an index of coding decision-points.

Additional research suggests that grammatical phrases in linguistic segments possess some measure of psychological reality. Subjects tended to maintain the integrity of grammatical units by subjectively displacing click interruptions toward the nearest syntactical boundaries (Fodor & Bever, 1965). Similarly, Marks (1967) demonstrated that linguistic strings with inversions that interrupted major phrase boundaries required longer identification times than phrases with intact boundaries. As might be expected if phrases are the subunits used in learning connected discourse, errors in learning phrase units were more likely to occur at the boundaries between units (Johnson, 1965). Finally, disturbing the integrity of phrase units during presentation interfered with the recall of the units (Anglin & Miller, 1968). The limited research literature thus suggested that some measure of phrase structure might be an important linguistic unit in meaningful learning.

To accomplish the task of measuring the phrase structure of the linguistic units (Johnson, 1968), three independent groups of 32 raters eliminated unimportant subunits until only 1/4, 1/2, or 3/4ths of the original number of words remained in the whole story. The number of times that each linguistic unit was retained in the story thus provided a measure of the structural importance of the linguistic unit.

The next step was a determination of the actual learning and recall of the linguistic units. Various samples of Ss tried to reproduce the story verbatim after retention intervals of 15 minutes, 7 days, 21 days, or 63 days. At the time of the original reading the Ss had been instructed to "read the story to yourself twice at your normal reading rate. At some future time you will be tested on the accuracy of your recall." The recall protocols were then rated to determine which linguistic subunits had been recalled.

Analysis of the results showed the structural importance of the units to be closely related to the actual learning or recall of the units. The correlations were high, ranging from .48 to .72, mean $r = .63$. Interestingly, the judgments of structural importance in which 1/4, 1/2, or 3/4ths of the words were eliminated all seemed to predict recall equally well. It is also of interest that the judgments of structural importance predicted recall equally well at all retention intervals.

The correlations between the relative recalls of the 66 units after the various retention-intervals were also high. The lowest correlation, between immediate reproduction and 63-day reproduction, was still a substantial .67. Although the number of recalled units

declined over the 63-day interval, the patterning of recall thus was similar at all retention intervals. An important generalization from this finding is that the structural patterning of recall does not depend upon the number of words which are recalled. Similarly, the linguistic structure of the folktale itself, as defined by the relative importance of the linguistic subunits, was shown to be independent of the number of words used in defining linguistic structure.

Problem and Objectives. If the relationship between learning and structural importance is generally true, the potential applications to the educational setting may be of great significance. Additional studies were therefore undertaken to test the generality of the relationship, or to clarify our understanding of the conditions under which structural importance is related to learning.

In brief, the seven experiments to be reported focus on four important questions. First, can the relationship between structural importance and learning be shown to be generally true for additional samples of prose stories? Second, are textbook passages also coded according to structural importance? Third, what is the mechanism by which important linguistic units are learned better? Fourth, does structural importance influence the memorization of prose?

Experiments I and II

The purpose of Experiments I and II was to determine whether the learning of other narrative folktales would also be related to the structural importance of the subunits.

Method

The two folktales used as experimental materials were revised versions of "The Hour Has Come But Not the Man" (Christiansen, 1964) and "Room For One More" (Briggs & Tongue, 1965). To increase objectivity in scoring, most of the repetitive events and phrases of the original stories were eliminated in the revised versions. The "Hour" story contained 375 words and 24 sentences; "Room" contained 339 words and 18 sentences.

Measurement of linguistic subunits. Pausal judgments were made on both stories by an original sample of 17 raters and a later sample of 21 raters. A copy of the rating instructions may be seen in Appendix B. The mean number of pausal slashes on "Hour" was 66.0 for the first sample, SD = 21.9, and 48.9 for the second sample, SD = 11.9. For the sample of 17, the mean subunit length was 6.1 words, SD = 1.6; the sample of 21 had a mean subunit length of 8.0 words, SD = 2.2. The correlation between the pausal judgments of the two groups of students was .95.

The pausal judgments by the original sample of 17 raters partitioned "Hour" into 58 linguistic units. Six of the units, however, were combined by E into larger units so that the final number of subunits was 52. Four of the combinations joined direct quotations with phrases telling the author of the quotation. The other units incorporated into larger phrases were two phrases designating the passage of time, e.g., "At last" and "all at once." The mean word length for the 52 phrases was 7.1, SD = 2.9. Twenty-five pausal boundaries were between sentences and 28 boundaries occurred within sentences. Six of the subunits were complete sentences. A copy of "The Hour Has Come But Not the Man," divided according to pausal acceptability units, may be seen in Appendix C.

"Room" received an average of 60.0 slashes, SD = 11.32, from the first sample of 17 raters and an average of 47.9, SD = 13.4, from the sample of 21 raters. The mean word lengths of the subunits were 5.7, SD = .9 for the first sample and 7.7, SD = 3.1 for the second sample. The correlation between the two samples on the pausal locations was .96.

Pausal judgments by the original 17 raters partitioned "Room" into a total of 57 subunits. Four units were combined with larger units to make a total of 53 subunits. Two of the combinations joined the author of a quotation to the quotation, and the other two combinations eliminated single word units. The mean word length of the final 53 subunits was 6.5, SD = 2.4. Nineteen of the pausal boundaries occurred between sentences while 35 boundaries occurred within sentences. All but one of the original 18 sentences was divided by a pausal boundary. A copy of "Room," as divided into pausal units, may be seen in Appendix D.

Measurement of structural importance. An independent sample of 56 student raters made judgments of structural importance which reduced "Hour" to 1/4th of its original length. A sample copy of the instructions given to raters of structural importance may be seen in Appendix E. Another independent sample of 48 raters made judgments which reduced "Room" to 1/4th of its original length.

After the data had been collected which reduced the stories to 1/4th of their original lengths, an additional 66 raters were randomly assigned either to a group eliminating 1/2 of the words in both stories or to a group eliminating 1/4th of the words in both stories. The order of the two stories was alternated in the packet received by the raters.

As a step in combining subunits into levels of structural importance, excessive Ss in the original samples of 56 and 48 raters were randomly removed until Ns of 33 were obtained in each of the groups. The frequency with which the 99 raters judged each of the units to be structurally important was tabulated. The 52 subunits in "Hour" were combined then into four groupings of 13 units ranging from the lowest 1/4th in structural importance to the highest 1/4th. "Room" also was combined into four groupings of 13 units. Since "Room" had 53 units after being divided by pausal judgments, the middlemost unit was not included in the groupings.

For the "Hour" story the correlation between mean word length of the units and the structural importance of the units, determined from 99 ratings of importance, was .05, $p > .05$. The same correlation for "Room" was .13, $p > .05$.

Measurement of recall. Four separate groups of students enrolled in educational psychology courses attempted to reproduce one of the stories from memory. An immediate reproduction of "Room" was attempted by 56 Ss; 21-day reproductions were written by another sample of 76 Ss. A third group of 58 Ss attempted an immediate reproduction of "Hour"; 77 Ss in a fourth group wrote the "Hour" story after a 21-day retention interval. Each S's reproduction was assigned four scores according to the number of linguistic units

recalled in each of the four levels of structural importance. The immediate reproductions were written immediately after reading the story rather than after a 15-minute delay.

Results

"Hour." The intercorrelations of the structural judgments in which 1/4, 1/2, or 3/4ths of the words were eliminated were .86 between 1/4 and 1/2, .69 between 1/4 and 3/4, and .84 between 1/2 and 3/4. The patterning of recall on immediate reproductions correlated..49 with the patterning of recall at 21 days. Correlations of immediate recall with judgments eliminating 1/4, 1/2, and 3/4ths of the words were .49, .45, and .56. On the 21-day reproductions the corresponding correlations were .42, ..47, and .59. The mean correlation between recall and structural importance was .50.

Mean recalls for each of the four levels of structural importance of "Hour" may be seen in Table 1. A correlated-measures analysis of variance of scores from the immediate reproductions showed structural importance to be significantly related to recall, $F(3,171) = 67.20$, $p < .01$. Newman-Keuls tests at the .01 level provided evidence that all mean differences were statistically significant except the difference between the 2nd and 3rd levels of importance.

Table 1

Mean Recall of Linguistic Subunits of "Hour" as a Function of Levels of Structural Importance

	Levels of Structural Importance			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=58)	11.24	8.29	8.22	7.41
21 days (N=77)	5.36	3.65	3.79	1.75

Similarly, analysis of scores from the 21-day reproductions of "Hour" showed structural importance to be related to recall, $F(3,228) = 66.81$, $p < .01$. Once again differences between means were significant at the .01 level except for the comparison between the 2nd and 3rd levels of importance.

"Room." The patterning of recall of the 43 units on the immediate reproductions correlated .77 with the patterning of recall at 21 days. Intercorrelations of the structural judgments in which 1/4, 1/2, or 3/4ths of the words were eliminated were .80 between 1/4 and 1/2, .61 between 1/4 and 3/4, and .86 between 1/2 and 3/4. On the immediate reproductions, the correlations of recall with judgments eliminating 1/4, 1/2, and 3/4ths of the words were .49, .59, and .51. The corresponding correlations at the 21-day interval were .60, .72, and .66. The mean r was .60.

Table 2 shows the mean recalls on "Room" for the four levels of structural importance. Repeated-measures analyses of variance showed structural importance to be related to recall at both the immediate retention interval, $F(3,165) = 168.90$, $p < .01$, and the 21-day interval, $F(3,225) = 318.35$, $p < .01$. Newman-Keuls tests at the .01 level gave evidence that all differences within each retention interval were significant except for the comparison between the Lowest and 3rd levels on the immediate reproductions.

Table 2

Mean Recall of Linguistic Subunits of "Room"

as a Function of Levels of Structural

Importance, Exp. II.

	Levels of Structural Importance			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=56)	12.57	10.77	8.14	7.93
21 days (N=76)	11.03	6.79	5.42	3.29

In summary, the results of Experiments I and II provide evidence that the relationship between learning and structural importance can be generalized to other narrative folktales. Units of high structural importance were remembered better than units of low structural importance.

Experiments III and IV

Experiments III and IV were conducted to determine whether the learning of linguistic segments within a textbook passage was also related to the structural importance of the segments. In addition, it was hypothesized that the learning of textual segments would be related to the meaningfulness of the segments as well as to structural importance.

Method

The textual passage written for Experiment III was a 650-word unit entitled "The Role of Language in Learning." The 5 paragraph passage had 19 sentences and was written at a difficulty level appropriate for college-level learners. In Experiment IV, the textual passage which was written was an 810-word unit called "Evolution of the Brain." "Evolution" contained 7 paragraphs and 40 sentences.

Measurement of linguistic subunits. Unless otherwise specified, the procedures used in Experiments III and IV were identical to the procedures used in Experiments I and II. A sample of 52 college students partitioned "Language" according to those locations in which it was acceptable to make a pause. The 69 pausal units which were formed by this method were reduced to a total of 60 units by combining four units which were in seriation (tailors, foresters, mechanics, and physicians), and by combining short-word units which were introductory sentence modifiers (In fact; If, for example; Incidentally; Similarly; and Obviously). The mean word length for the 60 verbal units was 10.8, SD = 4.84. Seven of the 60 units were complete sentences. Twenty pausal boundaries were at the junctions between sentences and 41 boundaries were located within the sentences. A copy of "Language," divided according to pausal units, may be found in Appendix F.

For "Evolution," 50 of the 52 college students who partitioned "Language" also provided useable data in segmenting the "Evolution" passage into 89 verbal units. Evidence that the process of making pausal judgments is reliable may be seen in the correlation coefficient of .97 between the judgments made by the first 16 college students in the sample and the judgments made by a second class of 34 students. As was done in Experiment III, the elimination of serial units and short modifiers compacted the 89 linguistic units into 80 units. Eleven of the 80 units were intact sentences. Forty-one of the pausal

boundaries occurred between sentences while 40 boundaries occurred within sentences. The mean subunit word length was 10.1, SD = 5.3. Appendix G shows a copy of "Evolution" divided according to pausal units.

Measurement of structural importance. Three separate groups of 33 raters were formed by alternately assigning raters to groups. All 99 raters were students in educational psychology courses who fulfilled a requirement of experimental participation. As in the earlier experiments, one group made judgments of structural importance of "Evolution" until the textual passage was only 1/4th of its original length. The other two groups of 33 raters eliminated either 1/4th or 1/2 of the words. A frequency tabulation for each pausal unit provided a measure of the unit's structural importance. The same groups which made ratings of the structural importance of "Evolution" also made ratings of the structural importance of "Language." To minimize misunderstandings, the raters were required to eliminate the same proportion of words in each of the two textual passages. Various rater errors, however, reduced the useable data on "Language" to three groups of 32 raters.

Measurement of meaningfulness. Ratings were also made of the meaningfulness of the pausal units. An independent group of 96 student raters was randomly assigned to three groups of 32. Raters eliminated either 1/4th, 1/2, or 3/4ths of the least meaningful words. As was done for ratings of structural importance, raters judged both textual passages and eliminated a similar ratio of words in each passage.

A copy of the instructions given to raters may be seen in Appendix H. Raters were instructed to make global ratings of the meaningfulness of the units by noting four important dimensions of meaningfulness. First, phrases with concrete and specific content were said to be more meaningful than abstract or general content. Second, phrases which readily aroused sensory imagery were said to be meaningful. Third, phrases containing familiar, easy-to-understand words were to be judged as meaningful. Fourth, phrases calling forth many associations with one's past experiences were also said to be meaningful.

Measurement of predicted recall. Toward the end of the present studies, a decision was made to collect additional data which would indicate whether students would be able to predict the phrase units which they would have remembered if they had actually been participants in the experiment. A sample of 48 raters received the rating instructions found in Appendix I. The number of raters eliminating 1/4th, 1/2, or 3/4ths of the textual passages was approximately equal. Since the number of raters in each group was somewhat small, however, a decision was made to combine the three groups for the purpose of analyzing the data.

Measurement of recall. Students in introductory educational psychology classes were assigned to immediate or 7-day reproduction groups on an alternate seat basis. After students read their textual passage twice, the learners in the 7-day groups were excused from the classroom. The remaining students then attempted an immediate reproduction of their textual passage. After the reproductions were completed, the students were requested not to discuss the experiment with their fellow students. Immediate reporductions of "Evolution" were made by 58 learners; 7-day reproductions were made by 56 of the learners who had been excused at the time of the immediate reproductions. Sample sizes for "Language" were 61 at the immediate interval and 46 at the 7-day interval. The lower sample sizes at the 7-day intervals were due to absenteeism and to learners' claims that they could remember absolutely nothing.

Two trained undergraduate raters made judgments as to which linguistic units had been remembered. Discrepancies in ratings were eliminated by agreement in conference. Instances in which the raters could not come to mutual agreement were decided by a third rater.

The linguistic units were rank ordered according to their structural importance and then separated into four groupings according to their structural importance. Each S then received four scores based upon the number of units recalled from the upper 1/4th in importance, the second 1/4th, the third 1/4th, and the lower 1/4th in importance. Similarly, the linguistic units were rank ordered according to their meaningfulness, and the patterning of recall for each S was examined to determine the number of units recalled in each of four levels of meaningfulness. The reproductions of learners were also scored to determine the correspondence of actual recall with the levels of recall predicted by the sample of student judges.

Results

"Language" - Structural Importance. Table 3 shows the mean number of recalled units for each of the four levels of structural importance. A repeated-measures analysis of variance of the immediate reproduction scores gave evidence that the remembering of linguistic units was related to their structural importance, $F\ (3,180) = 33.58$, $p < .001$. Newman-Keuls tests at the .01 level showed all differences between means to be statistically significant. Analysis of the 7-day reproductions also provided evidence that recall was related to the structural importance of the units, $F\ (3,135) = 11.20$, $p < .001$. Individual comparisons of means showed the 2nd level of structural importance to be higher than each of the other levels, $p < .001$. None of the other differences were significant either at the .01 or .05 level.

Table 3

Mean Recall of Linguistic Subunits of "Language"

as a Function of Levels of Structural

Importance

Retention Interval	Levels of Structural Importance			
	Highest	2nd	3rd	Lowest
Immediate (N=61)	3.62	6.48	5.66	4.46
Seven days (N=46)	1.33	3.02	1.93	1.87

An examination of means in Table 3 shows that the relationship between structural importance and recall was curvilinear for both retention groups. Contrary to expectation, the highest level of structural importance was not remembered well.

A two-way analysis of variance, with retention interval as one factor, and levels of structural importance as a second factor, permitted an assessment of whether the units at different levels of importance were forgotten at different rates. For this analysis, the data of 15 Ss in the immediate group were randomly eliminated to achieve equal-sized groups. Significant effects were evidenced for retention interval, F (1,90) = 81.95, $p < .001$, and for levels of structural importance, F (3,270) = 28.95, $p < .01$. The significant interaction term resulted from a greater percentage of forgetting of units in the highest level and in the third level of structural importance, F (3,270) = 3.54, $p < .05$.

"Language" - Meaningfulness. The relationship between meaningfulness and the remembering of the linguistic units of "Language" may be seen in the data of Table 4. Significant differences among groups were evident both on the immediate reproductions, F (3,180) = 135.58, and on the 7-day reproductions, F (3,135) = 35.93, $ps < .01$. Newman-Keuls tests, taken separately at each reproduction interval, showed all differences among means to be statistically significant at the .01 level.

Table 4

Mean Recall of Linguistic Subunits of "Language"

as a Function of Levels of Meaningfulness

	Levels of Meaningfulness			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=61)	7.72	6.16	3.92	2.41
Seven Days (N=46)	3.30	2.59	1.67	.59

A two-way analysis of variance of the meaningfulness data showed significant effects for retention interval, F (1,90) = 81.95, and levels of meaningfulness, F (3,270) = 125.08, $ps < .01$. The significant interaction between meaningfulness and retention interval, F (3,270) = 12.71, $p < .01$, resulted from the greater proportionate forgetting at the lower levels of meaningfulness.

"Language" - Predicted Recall. Analysis of the remembering of linguistic units gave evidence that raters can predict the units which will be learned and remembered. Table 5 shows the relationship between the actual recall of the subunits and the predicted recall. Significant differences among the means were evident both at the immediate interval, F (3,180) = 111.45, and at the 7-day interval, F (3,135) = 34.12, $ps < .01$. Newman-Keuls tests on the data from the immediate reproductions showed all differences between means to be significant. At the 7-day interval, the Highest and the 2nd levels were each superior to the recalls at both the 3rd and Lowest levels, $ps < .01$. The remaining two comparisons were not statistically significant, $ps > .05$.

Results from the two-way analysis of variance showed significant effects for the predicted-recall variable, F (3,270) = 106.89, retention interval, F (1,90) = 81.95, and the interaction term, F (3,270) = 6.75, $ps < .001$.

Table 5

Mean Recall of Linguistic Subunits of "Language"

as a Function of Levels of Predicted Recall

	Levels of Predicted Recall			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=61)	7.43	6.52	3.69	2.57
Seven Days (N=46)	3.35	3.00	1.04	.76

In summary, analyses of the remembering of the linguistic units of "Language" provided strong evidence that recall was related both to the structural importance of the units and also to the meaningfulness of the units. As a means of determining whether structural importance and meaningfulness were simply overlapping measures of the same variable, or whether the two variables were independent predictors of remembering, stepwise multiple regression analyses, were computed. At each step in the analysis, the independent variable entered into the regression equation was the variable accounting for the greatest proportion of residual variance. Independent variables continued to be added to the set of predictors until the standard error of estimate reached its minimum value for the criterion measure. Entry into the set of predictors was also withheld unless an analysis of variance showed evidence of a significant increment in the variance accounted for by the addition of the new variable.

One regression analysis of the remembering of the 60 pausal units at the immediate retention interval included nine potential independent variables: (1) serial order of the units; judgments of structural importance reducing size of passage to (2) 1/4th of its original length, (3) 1/2 its original length, (4) 3/4th of its original length; judgments of meaningfulness reducing passage to (5) 1/4th of passage highest in meaningfulness, (6) 1/2 of passage highest in meaningfulness, (7) 3/4ths of passage highest in meaningfulness; (8) number of words in each pausal unit, and (9) predicted recall of units by raters. For the three predictors which were in the optimum set, the multiple correlation coefficient was .80. The order in which the three predictors entered into the analysis, and the results of the test determining whether the variable accounted for variance

which had not been accounted for by the previous set of predictors were 3/4ths judgments of meaningfulness, F (1,58) = 45.39, $p < .001$, 1/4th judgments of structural importance, F (1,57) = 18.35, $p < .001$, and judgments of predicted recall, F (1,56) = 8.62, $p < .01$.

Analysis of the remembering of pausal units at the 7-day interval, with the same nine potential variables included in the analysis, resulted in an optimum set of four variables with a multiple correlation coefficient of .75. The four variables were 3/4ths judgments of meaningfulness, F (1,58) = 35.10, $p < .001$, serial order, F (1,57) = 8.36, $p < .01$, 1/4th judgments of structural importance, F (1,56) = 5.18, $p < .05$, and judgments of predicted recall, F (1,55) = 6.43, $p < .05$. In summary, analyses of both immediate and 7-day remembering of the linguistic units indicated that portions of recall could be predicted by three different predictors--measures of meaningfulness, structural importance, and predicted recall.

"Evolution" - Structural Importance. A repeated-measures analysis of variance of immediate reproduction scores, from each of the four levels of structural importance, showed significant effects for the structural importance variable, F (3,171) = 7.48, $p < .001$. Examination of the mean scores at each of the four levels, shown in Table 6, reveals a complex relationship between structural importance and recall. Application of the Newman-Keuls procedure shows the 2nd level was recalled better than any of the other levels: Highest, $p < .01$; 3rd level, $p < .01$; Lowest, $p < .05$. Other differences between means were not significant.

Table 6

Mean Recall of Linguistic Subunits of "Evolution"

as a Function of Levels of Structural Importance

	Levels of Structural Importance			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=58)	7.10	8.64	6.84	7.52
Seven Days (N=56)	3.93	4.02	1.84	4.75

Reproductions at the 7-day interval were also related to structural importance, F (3,165) = 28.23, $p < .001$. Contrary to predictions, the Lowest level was recalled better than the 3rd level, $p < .01$, and also better than the 2nd and Highest levels, $ps < .05$. The Highest and 2nd levels were also recalled better than the 3rd level, $ps < .05$.

A two-way analysis of variance, with two learners randomly removed from the immediate group to achieve equal sample sizes, showed significant effects for the retention interval, F (1,110) = 102.99, levels of structural importance, F (3,330) = 23.63, and the interaction term, F (3,330) = 7.49, $ps < .001$. Inspection of Table 6 suggests that the significant interaction term resulted from the disproportionately large amount of forgetting at the 3rd level of importance.

"Evolution" - Meaningfulness. The meaningfulness variable was strongly related to recall both at the immediate interval, F (3,171) = 205.57, and the 7-day interval, F (3,165) = 105.90, $ps < .001$. Mean scores for each of the levels of meaningfulness may be seen in Table 7. Individual comparisons between the means showed all differences were significant within each of the retention intervals, $ps < .01$. It should be noted that the linearity of the relationship between meaningfulness and recall was broken by unexpectedly high recall for the 3rd level of meaningfulness.

Table 7

Mean Recall of Linguistic Subunits of "Evolution"

as a Function of Levels of Meaningfulness

	Levels of Meaningfulness			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=58)	10.50	7.81	9.40	2.26
Seven Days (N=56)	5.79	3.32	4.64	.73

As might be expected from an inspection of means in Table 7, a two-way analysis showed significant effects for the retention interval, F (1,110) = 104.12, levels of meaningfulness, F (3,330) = 294.10,

and the interaction term, $F(3,330) = 20.62$, $ps < .001$. The Highest level was remembered somewhat better than the average, while the level of remembering of the Lowest level was relatively poor.

"Evolution" - Predicted Recall. Recall of the linguistic units was related to the recall levels predicted by the independent group of college raters. The relationship was evident both at immediate recall, $F(3,171) = 96.34$, and at 7 days, $F(3,165) = 68.14$. At both of the retention intervals, all differences between levels were significant except for the differences between the 2nd and 3rd levels, $ps < .01$. Inspection of the mean levels of recall, shown in Table 8, indicates no appreciable deviations from an ordinal ordering of means.

Table 8

Mean Recall of Linguistic Subunits of "Evolution"

as a Function of Levels of Predicted Recall

	Levels of Predicted Recall			
Retention Interval	Highest	2nd	3rd	Lowest
Immediate (N=58)	9.76	8.24	8.28	3.69
Seven Days (N=56)	5.71	3.89	3.66	1.21

A two-way analysis of variance showed significant effects for the retention interval, $F(1,110) = 104.12$, and for the levels of predicted recall, $F(3,330) = 157.79$, $ps < .001$. The significant interaction term, $F(3,330) = 7.33$, $p < .001$, arises mainly from the disproportionate forgetting of the linguistic units in the lower levels of predicted recall.

Stepwise multiple regression analyses of the remembering of the pausal units provided information on whether meaningfulness and structural importance were making independent contributions in accounting for the recall variance. The set of nine potential independent variables used in the analyses was analogous to the

variables included in the analyses of "Language." Predictors accounting for a significant proportion of the recall variance at the immediate interval included 3/4ths judgments of meaningfulness, F (1,78) = 35.11, $p < .001$, 3/4ths judgments of structural importance, F (1,77) = 14.02, $p < .001$, and judgments of predicted recall, F (1,75) = 7.66, $p < .01$. The optimum set of predictors for 7-day recall included judgments of predicted recall, F (1,78) = 17.74, $p < .001$, serial order, F (1,77) = 7.45, $p < .01$, 1/4th judgments of structural importance, F (1,76) = 5.92, $p < .05$, 3/4ths judgments of meaningfulness, F (1,75) = 6.01, $p < .05$, and 3/4ths judgments of structural importance, F (1,74) = 8.81, $p < .01$.

In summary of the regression analyses, at least three variables made independent contributions to the prediction of recall. Although the measures of meaningfulness, structural importance, and predicted recall were correlated with each other, these same variables also accounted for differing portions of the recall variance. The independent roles of these three variables was evident both at immediate recall and at 7-day recall.

Overall, the results of Experiments III and IV provide clear evidence that the remembering of textual segments was related to their judged structural importance. It is also evident, however, that the relationship is not a simple one. For both "Language" and "Evolution," the relationship between structural importance and remembering was curvilinear. Recall of the units in the highest level of importance was unexpectedly poor. Some evidence also indicated that the remembering of the least important units of "Evolution" was unexpectedly good.

Experiments III and IV also provided evidence that the remembering of textual units was related to the meaningfulness of the units. Generally, the higher the meaningfulness of the linguistic subunits, the better was recall. The only exception to this generalization was the relatively high recall of the units in "Evolution" which were in the next-to-lowest level of meaningfulness.

Experiment V

The purpose of Experiment V was to determine whether the relationship between structural importance and recall might have occurred because more learning time was allocated to the linguistic units of high structural importance. As a test of this possibility in the present experiment, the linguistic segments of "The War of the Ghosts" were each displayed individually in their usual serial order. The presentation time for each unit coincided with the amount of time needed to read the particular unit which was being displayed.

Method

Each of the 66 linguistic units of "Ghosts" was photographed and placed on a 2 x 2 slide. To increase the continuity in presentation, a Kodak Dissolve Control was used to mediate the operation of two Carousel 800 Series slide projectors. The actual presentation rate of each slide was controlled through a prerecorded tape played through a Model 5730 Wollensak two-channel recorder. In the initial recording session, the story was read orally at a moderate pace into one channel of the recorder, and a Kodak Programmer (Model 1) was used to produce triggering blips in the second channel. During the actual presentation of slides in the experiment, both channels of the recorder were totally silenced by jacks to the external speakers. The only sound at exposure thus was the usual operational noise of the projectors.

After the presentation, students sitting in alternate seats in an educational psychology class were excused and tested after a retention interval of three weeks (N = 48). The remaining students (N = 57) attempted to reproduce the narrative immediately. In subsequent analyses of the reproductions, the ratings of accuracy of recall of the various verbal units were correlated with the judgments of structural importance gathered in the experiment described in the introductory section of this report (Johnson, 1970).

Results

As in the earlier experiment, the patterning of recall on the immediate reproductions was similar to the patterning of recall at 21 days, r = .76. Correlations between the patternings of immediate recall and the judgments eliminating 1/4, 1/2, and 3/4ths of the words were .58, .63, and .50. For 21-day recall, the corresponding correlations were .56, .66, and .69. The mean correlation for the six coefficients is .61. Substantial relationships between structural importance and recall thus were found even under the restrictions of a paced presentation.

The paced presentation, in fact, led to patternings of recall that were similar to the patternings from the self-paced readings in the earlier experiment. On the immediate reproductions the correlation between the patternings of recall of the earlier experiment and the present experiment was .91. At the 21-day interval the patternings of the two experiments were also correlated .91.

The mean recall for the six levels of structural importance may be seen in Table 9. A repeated-measures analysis of variance of the scores from the immediate reproductions gave evidence that

structural importance was associated with recall, $F(5,280) = 83.93$, $p < .01$. Newman-Keuls tests at the .01 level showed all differences among means to be significant except for the difference between the Lowest and 5th level. At the 21-day interval, structural importance was associated with recall once again, $F(5,235) = 97.35$, $p < .01$. Newman-Keuls tests provided evidence that 11 of the 15 differences among means were statistically significant at the .01 level; in addition, the difference between the Lowest and 4th levels reached significance at the .05 level. The differences which were not statistically significant were Lowest with 5th, 5th with 4th, and 3rd with 2nd.

Table 9

Mean Recall of Linguistic Subunits of "Ghosts"

as a Function of Levels of Structural

Importance, Experiment V

	Levels of Structural Importance					
Retention Interval	Highest	2nd	3rd	4th	5th	Lowest
Immediate (N=57)	8.96	8.12	6.93	6.16	4.77	4.35
21 Days (N=48)	6.29	4.23	3.77	2.06	1.65	1.29

A two factor repeated-measures analysis of variance, with nine Ss randomly removed from the immediate group to make equal Ns, showed significant effects for the retention interval, $F(1,94) = 86.15$, $p < .01$, and for structural importance, $F(5,470) = 161.34$, $p < .01$. The significance of the interaction term, $F(5,470) = 2.54$, $p < .05$, suggested differential forgetting for the levels of structural importance.

Although the interaction term was significant, the lack of ordering of the mean amounts of forgetting, as a function of structural importance, suggests differential forgetting is not directly related to structural importance. The amounts forgotten for the six levels of importance, going from Lowest to Highest, were 3.02, 3.13, 3.94, 3.06, 3.71, and 2.71. In addition, the

patterning of the judgments of structural importance for the 66 subunits, as summed over 96 raters, was not related significantly to the percentages of forgetting of the respective subunits, $r = -.08$, $p > .05$.

In summary, the results of Experiment V have given clear evidence that the relationship between structural importance and recall cannot be attributed to learning strategies in which additional learning time is allocated to the linguistic segments of high structural importance. Despite the procedure which limited each verbal unit to just a single exposure, there was still a strong relationship between structural importance and recall.

Experiments VI and VII

In the final two experiments of the series, learners attempted to serially anticipate each of the succeeding verbal units of "Ghosts." The general purpose of the two experiments was to determine whether structural importance was related to recall in a serial learning situation. In Experiment VI, the learners controlled the presentation rates of the units by advancing the exposure apparatus whenever they were ready for the next verbal unit. In Experiment VII, the presentation rates of the units were controlled automatically.

Method

As in Experiment V, the verbal units were presented through two Kodak Carousel projecters linked together by a Dissolve Control. Learners in Experiment VI advanced the apparatus by pushing a button on a remote control switch. The participants viewed the slides on a projection screen for an initial exposure trial and then received three additional trials in which attempts were made to anticipate each of the succeeding units before its actual appearance on the screen. If the unit had not been anticipated, the learner was required to read the unit as it appeared on the screen. Guessing was encouraged for those instances in which the learner was uncertain as to what the next unit would be. On the occasions in which the learner judged himself to be void of knowledge concerning the next unit, he was told to say "Pass" and then to advance the apparatus.

The exposure apparatus in Experiment VII was controlled by the same method used in Experiment V. Since the timing operations were different, however, a new controlling tape was produced in which the triggering blips were placed in their appropriate locations. During the initial presentation trial, the exposure time of each unit corresponded with the amount of time needed to read the unit. On the three subsequent anticipation trials, the exposure interval for each unit was the amount of time needed to read the unit plus an additional five seconds. If the learner had not been able to

anticipate a particular unit, he was instructed to say the unit after it appeared on the screen and then to use his remaining time trying to anticipate the unit which would appear next. Since the exposures were automated, the requirement to say "Pass" was not appropriate to this experiment.

The intertrial intervals in both experiments were one minute. Responses of the learners were tape recorded and later transcribed onto coding sheets. To allow each of the two raters exact knowledge as to when the apparatus changed, an additional microphone was located adjacent to the Dissolve Control. The noise of the changing slides was then recorded on the second track of a tape recorder at the same time that the learner's responses were recorded on the first channel of the recorder.

Forty learners were tested in Experiment VI. A second group of 40 Ss was tested in Experiment VII. Learners were recruited from educational psychology classes and were tested individually.

Results

Experiment VI. The mean levels of recall on each of the three anticipation trials, as related to the six levels of structural importance, are shown in Table 10. Analysis of variance, with repeated measures across three trials and also within six levels of structural importance, showed significant effects for trials, F (2,78) = 314.05, $p < .001$, and structural importance, F (5,195) = 30.81, $p < .001$. The interaction term achieved marginal significance, F (10,390) = 2.14, $p < .05$. Separate analyses of variance showed that structural importance was related to recall on each of the three serial anticipation trials, first trial, F (5,195) = 16.94; second trial, F (5,195) = 16.35; third trial, F (5,195) = 17.95, $ps < .001$

Counts were made of the mean numbers of times that each of the 66 linguistic units was an intrusion. Measures of structural importance were significantly correlated with both the number of intrusions on the first anticipation trial and also with the number of intrusions on all three trials. Specifically, the correlations of the number of intrusions on the first anticipation trial with measures of structural importance in which 1/4th, 1/2, and 3/4ths of the passage were eliminated were .40, .43, and .38, respectively. The corresponding correlations with total intrusions were .37, .39, and .25. All correlations were significant at the .01 level except for the correlation of .25 which was significant at the .05 level. Although the intrusion data gave evidence that increases in structural importance were associated with increases in the general availability of the responses, as indexed by the intrusions, neither of the intrusions measures was significantly correlated with the total numbers of correct responses over the three trials, $ps > .05$.

Table 10

Mean Recall of Linguistic Subunits of "Ghosts"
as a Function of Levels of Structural
Importance, Experiment VI

	Levels of Structural Importance					
Trials	Highest	2nd	3rd	4th	5th	Lowest
First	4.08	3.63	3.18	2.15	3.00	1.53
Second	5.95	6.25	5.10	4.33	5.55	4.13
Third	7.50	7.75	6.73	5.85	7.63	6.00
Total	5.84	5.88	5.00	4.11	5.39	3.88

Experiment VII. Although the presentation rates were controlled automatically in Experiment VII, the data of Experiment VII were very similar to that of Experiment VI in which the presentation rates were controlled by the learners. The correlation between the numbers of correct responses in the two experiments was .94, $p < .001$. Similarly, the numbers of intrusions on the first anticipation trial, $r = .91$, and the total numbers of intrusions, $r = .91$, were also highly correlated, $ps < .001$.

Table 11 shows the mean levels of recall, as a function of levels of structural importance, for each of the three anticipation trials in Experiment VII. A 3x6 analysis of variance, with repeated measures on both variables, showed significant effects for trials, $F(2,78) = 314.11$, and for levels of structural importance, $F(5,195) = 31.06$, $ps < .001$. The interaction term was not significant, $F < 1$. Structural importance was related to recall on the first anticipation trial, $F(5,195) = 14.46$; the second trial, $F(5,195) = 14.19$; and the third trial, $F(5,195) = 16.27$, $ps < .001$.

Table 11

Mean Recall of Linguistic Subunits of "Ghosts"

as a Function of Levels of Structural

Importance, Experiment VII

	Levels of Structural Importance					
Trials	Highest	2nd	3rd	4th	5th	Lowest
First	4.13	3.95	3.15	2.45	2.88	1.90
Second	6.38	6.10	5.68	4.70	5.10	4.05
Third	8.30	8.25	7.03	6.30	7.38	6.13
Total	6.27	6.10	5.28	4.48	5.12	4.03

As in Experiment VI, the mean number of intrusions was related to measures of structural importance. Intrusions on the first anticipation trial correlated .41, .49, and .41 with measures of structural importance in which 1/4th, 1/2, and 3/4ths of the passage were eliminated, ps $<$ .001. The total number of intrusions was correlated .44, .32, and .44 with the 1/4th, 1/2, and 3/4ths measures of structural importance, ps $<$ .001. Once again, the correlations of the intrusions measures with the total correct responses were negligible, rs of .14 and -.01, ps $>$ .05.

In summary, the results of Experiments VI and VII have shown additional generality for the relationship between recall and the structural importance of linguistic subunits. Even under the constrained conditions of serial learning, the relationship was strongly evident on each of the three anticipation trials. In Experiment VI, the presentation rates of the linguistic units were under the control of the learners. In Experiment VII, the presentation rates were controlled automatically to ensure that each unit would be exposed only for the time needed to read that unit a single time. Regardless of the method of controlling the presentation rates, there was a strong relationship between the structural importance of the units and their remembering.

General Discussion and Conclusions

Repeated confirmations of the relationship between structural importance and recall, under a variety of experimental conditions, attest to the durability of the relationship. In the seven experiments, the experimental manipulations included five samples of prose, four retention intervals, three measures of structural importance, and four different methods of presentation. Regardless of the experimental variations, a substantial relationship was found between structural importance and recall.

The high intercorrelations of the various measures of structural importance, and their general similarity in predicting recall, are of particular significance. The number of phrase units eliminated during judgments of structural importance was an unimportant determinant of the hierarchical orderings of phrase units. Stated more generally, the linguistic structure of the samples of prose, defined by the relative importance of the linguistic units, remained invariant despite the ablations which reduced the samples of prose to one-fourth of their original lengths.

Although the number of recalled units declined as the length of the retention interval increased, the patterning of recall was similar at all retention intervals. Like the linguistic structure of the folktale itself, the structural patterning of recall does not depend upon the number of words which are recalled.

Since a relationship existed between learning and the structural importance of the verbal units, it is apparent that learners somehow categorized the verbal units according to their structural importance. The results of Experiment III and VII, in which each unit was exposed only a single time, demonstrated that the relationship between recall and structural importance was not due to the learners spending additional learning time on the important units. The results also demonstrate that the categorization of units occurs as the units are apprehended. Learners apparently can categorize the earlier occurring units without having knowledge of the nature of the later occurring units.

In addition to demonstrating an objective method for subdividing complex verbal materials into functional subunits, the present experiments have also demonstrated a method whereby linguistic units within discourse can be ordered according to their structural importance in a prose passage. Such hierarchical orderings, in turn, accurately predicted the learning of the verbal units. Generally, the higher the structural importance of the linguistic units, the better was recall. Based upon this finding, textbook authors would do well to increase the perceived importance of pivotal concepts.

The practical applicability of this finding, however, is limited by the curvilinearity of the relationship. For some unknown reason, the textual units judged to be in the highest level of structural importance were not remembered well. Additional complexity may be observed in the patterning of results of the recalls of "Evolution." At 7 days, but not on the immediate reproductions, the lowest level of structural importance was remembered unexpectedly well.

Measurements of structural importance thus predicted the learning of discourse in a manner analogous to the use of associative norms in predicting the learning of isolated verbal units. The similarity with which associative values and structural importance predict learning, however, should not obscure the differences. Judgments of structural importance, for example, are based upon relationships among the units being judged. Excepting some general anchoring effects, measurements of association values are probably less determined by the context afforded by the other units which are to be judged. A second difference is the basis or dimension on which the judgments are made. The major dimension of association values is familiarity or meaningfulness. In contrast, the judgments of structural importance can be made for linguistic subunits which are all quite familiar. When textual subunits are not easily differentiated on the basis of differences in meaningfulness, the measurement of structural importance may assume a higher strategic importance in attempts to predict the recall of the units.

The curvilinearity of the relationship between structural importance and the recall of textual subunits suggests that textual prose is influenced by variables other than those determining the remembering of narrative prose. One differentiating variable may be meaningfulness. As noted earlier, the units in narrative prose are all quite familiar and are usually high in meaningfulness. Textual prose, however, differs in that the linguistic units usually show considerable variation in meaningfulness. The variation in meaningfulness assumes particular significance because many units of high structural importance are abstract and difficult to grasp conceptually. In contrast, textual units which serve lesser roles as illustrations or examples are concrete, familiar, and easy to understand. There are substantial correlations between measures of structural importance and measures of meaningfulness, but it is also apparent from inspection of the scatter-diagrams, and from the multiple regression analyses, that both variables are determinants of the patterning of recall.

An important contribution of the present studies has been the development of a method for measuring the meaningfulness of linguistic subunits within a textual passage. Up until now, decisions concerning the meaningfulness of phrases and ideas had

been decidedly subjective in nature. Use of the present method of measuring meaningfulness may stimulate additional studies on the role of meaningfulness in prose learning and retention.

Meaningfulness is one of the most potent determinants of the learning of nonsense syllables and lists of words. Based upon the recall patterns shown in the remembering of "Language" and "Evolution," it seems certain that meaningfulness is also a powerful determinant of the learning of textual prose. Recall of the units rated highest in meaningfulness was three to eight times greater than the recall of units rated lowest in meaningfulness. Meaningfulness is apparently as important a determinant of the learning of prose as it is of the learning of isolated verbal units.

Interestingly, raters possess knowledge as to the linguistic units which are likely to be remembered. Perhaps this knowledge is gained through attempting to learn units which are similar in nature. Equally likely, however, is that raters can discriminate differences in meaningfulness among the units and then base their predicted recalls upon the differences. Similarly, perceived differences in structural importance may also help the raters to make judgments of predicted recall. In stepwise multiple regression analyses, with predicted recall as the dependent variable, the first two variables to be entered into the regression equations, for "Language" and also "Evolution," were meaningfulness variables. After entry of the two meaningfulness variables, the multiple correlation coefficient for "Language" was .83; for "Evolution," the multiple correlation coefficient was .75. In each analysis, the third significant independent variable entering into the equation was a measure of structural importance. Briefly then, the judgments of predicted recall are closely related to judgments of meaningfulness and also to judgments of structural importance.

Methodologically, the technique used in partitioning the textual passages into smaller segments possesses the potential of having wide applicability to the analysis of text. The division of text according to locations of pausal acceptability was an efficient means of partitioning texts into units possessing psychological significance. Ratings of recall and the measurements of structural importance, meaningfulness, and predicted recall were all based upon the segmentations resulting from pausal judgments. The successful confirmation of a relationship between recall and the hierarchical orderings of the linguistic units suggests that learners do segment prose at the locations which are psychologically acceptable for pausing. Since the technique of segmenting prose into pausal units is objective, reliable, and psychologically significant, the method would seem to have considerable merit over the subjective judgments which have been used in the past.

Another methodological innovation has been the development of a technique whereby linguistic subunits within a prose passage may be hierarchically ordered according to a rating dimension. In the present studies, subunits of prose were rated according to their structural importance, their meaningfulness, and their predicted recall. The technique of having raters eliminate a specified portion of text, according to the characteristic being rated, is applicable to other variables also. A segment of text could easily be rated according to any rating dimension that might be relevant to an understanding of why some linguistic subunits are remembered better than are other subunits.

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Appendix A

The War of the Ghosts

One night/two young men from Egulac/went down to the river to hunt seals,/ and while they were there/it became foggy and calm. /Then they heard war-cries,/ and they thought: /"Maybe this is a war-party." /They escaped to the shore, /and hid behind a log. /Now canoes came up, /and they heard the noise of paddles, /and saw one canoe coming up to them. /There were five men in the canoe, /and they said:/

"What do you think? /We wish to take you along./ We are going up the river to make war on the people."/

One of the young men said, /"I have no arrows."/

"Arrows are in the canoe," /they said./

"I will not go along./ I might be killed./ My relatives do not know where I have gone./ But you,"/ he said,/ turning to the other,/ "may go with them."/

So one of the young men went, /but the other returned home.

And the warriors went on up the river/to a town on the other side of Kalama./ The people came down to the water,/ and they began to fight,/ and many were killed./ But presently/the young man heard one of the warriors say:/ "Quick,/ let us go home-/-that Indian has been hit."/ Now he thought:/ "Oh,/ they are ghosts."/ He did not feel sick,/ but they said he had been shot./

So the canoes went back to Egulac,/ and the young man went ashore to his house,/ and made a fire./ And he told everybody/and said:/ "Behold/ I accompanied the ghosts,/ and we went to fight./ Many of our fellows were killed,/ and many of those who attacked us were killed./ They said I was hit,/ and I did not feel sick."/

He told it all,/ and then he became quiet./ When the sun rose/ he fell down./ Something black came out of his mouth./ His face became contorted./ The people jumped up and cried./

He was dead./

Appendix B

Instructions - Pause Acceptability

Task? To divide the story into sub-units so that further analyses may be made of performances on the story.

Your immediate task is to make judgments as to where it would be acceptable to pause in the story. The function served by making a momentary pause might be to catch a breath, to give emphasis to the story, or to enhance meaning.

To indicate a pause, make a diagonal slash.

Suggestions or rules to be used in making judgments:

(1) Assume that a pause would always be acceptable at the end of a sentence.

(2) Most commas, semicolons, and colons are located in spots where a pause would be acceptable.

(3) A pause is usually acceptable at the junctions between coordinate clauses (joined by a connective such as and, but, or).

(4) Subordinate clauses, which begin with words such as after, although, as, because, before, if, since, though, and unless, are usually acceptable places for pausing.

(5) It may help you in your judgments to read the sentence subvocally or orally and actually take a breath or pause to see if the location is an acceptable location for pausing.

(6) You should not deny a slash just because you wouldn't have so many breaths or pauses if you were actually reading the story. Your task is not to divide the story into the minimum number of units. Instead, your task is to break the story into all those units in which a pause might be acceptable.

Appendix C

"THE HOUR HAS COME BUT NOT THE MAN!"

To be found in Folktales of Norway (R. T. Christiansen, ed.), University of Chicago Press, 1964.

Appendix D

ROOM FOR ONE MORE

To be found in Folktales of England (K.M. Briggs and R.L. Tongue, eds.), Routledge and Kegan Paul, London, 1965.

Appendix E

Rating Information - Judgments of Structural Importance

Your task is one of making judgments as to the importance of the various phrases and sentences to the structural importance of the whole story.

The actual procedure that is to be followed is to cross-out the least important elements or phrases of the story until you have reduced the story to the number of words indicated by the number in red ink in the upper right-hand corner of your copy of the story.

For example, if you have the story called "Room For One More" and the number in red ink is 85, your task is to eliminate the 254 words which are the most unessential to the 339 word story. If your story is "The Hour Has Come But Not The Man" and has the number 94 in red ink, your task is to eliminate the 281 words which are the most unessential to the 375 word story.

A rule to be followed in cutting the story down to the required size is that only phrase-size units can be eliminated. The boundaries of the phrases in this story are marked by diagonal slashes.

For example, suppose that the first phrase in the story was "Once upon a time." If you decided that this phrase was not as important as other phrases, you would cross out "~~Once upon a time.~~" Note that it is not permissible to cross out units unless they are bounded by diagonal slashes; you could not, for example, separately cross out the words "upon a time" and allow "Once" to remain.

To be considered as legitimate data, your abbreviated story must be within plus or minus five words of the number written in red.

It is vital, therefore, that your word-counts be accurate. Since it is so easy to err, it is suggested that the final count be done at least twice - one forward count and one backward count.

The title is to be included in your count. Contractions count as two words.

If you cross-out a phrase and later decide to keep it, draw a circle around the crossed-out phrase and write "keep" within that circle.

Before starting the job of elimimating phrases, read the entire story. Then start be eliminating the least important units first.

A verbal description of the basis for your judgments cannot be stated easily, yet you probably will not have too much difficulty in making judgments as to which of the phrases are of lesser importance. Presumably they are the phrases which could be eliminated and yet the essence of the story would be retained. Alternately worded, some phrases or ideas are structurally more important than are others. The elimination of some phrases would "hurt" the story; the elimination of other phrases would result in only minor losses for the total story.

Appendix F

The Role of Language in Learning

/Does having names for stimuli help one respond differentially to them?/Does it help one remember them,/or use them in further problems?/

One thing seems clear:/Having different names for things does not increase our absolute capacities for making perceptual discriminations./ Perhaps you have heard that workers in dye factories learn many more names for colors/and hence become better able to discriminate colors./ In fact, highly skilled workers in occupations dealing with color,/or any other sensory dimension,/are no better able to make psychophysical discriminations than the average person/(unless they have been selected for sensory ability in the first place)./But the special names they learn for colors <u>do</u> help in one way:/they facilitate communication,/and what is more interesting for the present discussion,/they enhance the ability of people to recognize and identify particular hues from memory./ In one part of an experiment by Brown and Lenneberg,/it was established that colors differed in the extent to which they were named easily and promptly,/and in the extent to which there was high agreement on names./ In the second part of the experiment,/four of the colors were simultaneously presented to learners for a period of three seconds./Then after a half minute,/120 colors were shown to the learners,/and they were required to identify the four colors shown earlier./ The results showed that the colors most easily named in the first part of the experiment were the ones easiest to recognize./When the learners were asked how they performed this task,/they reported naming the colors during the original exposure/ and then using the remembered labels in finding the colors on the large chart./

The superior potency of a <u>word</u>/as a carrier of a sensory impression/ is revealed even when equal amounts of attention are paid to the stimuli during initial learning./Kurtz and Hovland's experiment provides a good illustration of this fact./One group of children circled on a sheet of paper the <u>words</u> that went with a series of objects being shown to them,/ while another another group circled <u>pictures</u> of these objects./One week later,/ the first group of children showed superior recall and recognition of the objects that had been shown./

On an intuitive basis,/ it also seems plausible that there would be qualitative changes in memory toward the direction of the verbal categories./If, for example, a learner labeled some political event as a <u>boomerang</u>,/and this designation was only partially correct,/we might expect that the surplus meanings of the word <u>boomerang</u> would influence the quality of learning and retention./In one experiment in which 427 high school students were used as subjects,/one third of the learners were told their stimulus-figure resembled a "Christian cross,"/ another third was told the figure resembled a "street intersection,"/ and an additional third was given no label./Incidentally, the learners receiving no label probably supplied their own verbal tags./After a six-months retention interval,/there was still clear evidence that the errors of the learners were biased in the direction of their verbal label./

People do respond selectively to various attributes of their environment./Barbers are more likely to notice differences in hair style than the average person would./Similarly, tailors, foresters, mechanics, and physicians are all specially tuned to differing aspects of their environment./Obviously, these differences in response-tendency come about through learning,/but there is evidence that language can play a special role in this learning./The very existence of contrasting words for different categories/or for different values of a dimension/ draws attention to these categories or values./If a person has to learn to use these words in an acceptable way,/he must of necessity notice and discriminate the corresponding stimuli./The effect of language is thus to make the differences among stimuli more noticable,/or salient,/ than they would otherwise be./

Appendix G

Evolution of the Brain

/The study of similarities and differences among the various species clearly demonstrates that whenever there is behavior resemblance,/there is a resemblance of brains./ The actual size of the brain is not in itself of great psychological significance,/for several animals have brains much larger than man's./ The human brain has an average weight of about three pounds/ compared with ten pounds for an elephant/and fourteen pounds for a whale./ The ratio of brain weight to body weight is much more significant psychologically than mere brain weight./ This ratio is about 1/50 for man,/1/500 for the elephant,/ and 1/10,000 for the whale./

As animals grow larger,/more brain tissue must be present for mere sensory and motor connections,/and for control of physiological functions such as respiration and digestion./ A brain concerned entirely with these elementary tasks,/ no matter how large,/ is no more advantageous than a small one which serves the same functions in a small animal./ The larger the brain in proportion to body weight, however,/the larger the amount of neural tissue not reserved for routine sensory, motor, and physiological activities./

As we climb the vertebrate ladder,/the principle change in the nervous system is in the enormous growth of the cerebral hemispheres./ The brains of higher animals thus have a modern superstructure that is added to the common mechanism,/and the richness of the superstructure is directly related to the animal's proximity to the top of the scale./ Thus, the neural structures which are common to all members of the vertebrates/ must be the structures that are responsible for integrating responses common to all members of the vertebrate group./ The higher centers,/the new centers,/are thus mechanisms for the kinds of behaviors that distinguish the behaviorally simple from the behaviorally complex creature./

From lower animals to man,/there is an increasing dependence upon the two cerebral hemispheres for all complex psychological functions./ Visual discrimination provides a good illustration of this fact./ No part of the fowl's cerebral cortex is necessary for distinguishing a triangle from a circle of the same size and brightness./ When the visual portions of the cerebral cortex of a rat, cat, or dog are removed, however,/such discrimination of visual detail becomes impossible./ Only a crude brightness remains./ Destruction of the visual areas on man's cerebral cortex is even more disastrous,/ for total blindness results./ Cerebral injuries in man thus are more harmful to his psychological processes/than are similar injuries in animals./

Mammals are distinguished from other animals/in that all mammals possess a well-developed cerebral cortex./ The cortex is least extensive in the brains of primitive mammals,/for such animals have smooth cerebral hemispheres./ Beginning with animals like the cat and the dog, however,/ a wrinkling becomes apparent./ In general,/ the higher the animal's evolutionary status,/the more wrinkled its cerebral cortex./ Such wrinkling is due to the fact the cerebral cortex,/which is the covering of the cerebral hemisphere,/ has evolved faster than the skull case./ The area of the cortex thus was able to increase in size only by folding inward (invaginating)./ In man,/ the folding is so extensive/that more than two thirds of the cerebral cortex is buried in the many fissures that cleave the surface of the hemispheres./

The most distinguishing feature of the human cortex is the prominence within it of regions that are neither sensory nor motor in function./ Like other characteristics, however,/this evolutionary development has been a gradual one./ A comparison of the brains of the lower animals with man will be instructive./ The cerebral cortex of the rat is devoted almost entirely to sensory and motor functioning./ In the cat these sensory and motor areas have drifted apart./ Now it is possible to distinguish prominent strips of a third kind of area,/and we call this new area the associative cortex./ The brain of the monkey,/continuing the trend,/has huge associative expanses,/ one in the frontal area of the cortex/and another in the posterior region./ These frontal and posterior associative areas dominate the brain of man/and almost overshadow the sensory-motor areas that form the bulk of the system in the lower mammals./

The associative regions of the cerebral cortex have long been described as silent areas./ When the first investigators began to electrically stimulate the brain,/ they found that most patients were completely unable to detect the artificial stimulation,/ Since stimulation of these areas does not provide much information,/ our understanding of their functions has come largely through the assessment of the effects of brain damage./ When the associative areas suffer damage,/there is often an accompanying intellectual deterioration./ Although the data are not entirely convincing,/most investigators believe that the associative areas permit man to solve problems of great intellectual complexity./ Such an option is not available to the lower animals./

Appendix H

Rating Information - Judgments of Meaningfulness

Your task is one of making judgments of the meaningfulness of the various phrases or sentences to the total textbook passage. Although psychologists have been able to measure the meaningfulness of isolated words in lists, no one has successfully measured the meaningfulness of linguistic units in textual excerpts. Let us see if we can accomplish this important task.

The actual procedure that is to be followed is to cross-out the least meaningful phrases until you have reduced the words of the textual passage to the number of words indicated by the number in red ink in the upper right-hand corner of your copy. For example, if the number in red ink on the textual excerpt called "Evolution of the Brain" is 405, your task is to eliminate the 405 words which are the least meaningful in the 810 word textual passage. If your number in red ink is 608, you are to eliminate 202 words. If your number in red ink is 202, you should eliminate 608 words.

In the selection called "The Role of Language in Learning," if the number in red ink is 325, your task is to eliminate the 325 words which are the least meaningful in the 650-word passage. If your number in red ink is 487, you are to eliminate 163 words. If your number in red ink is 163, you should eliminate 487 words.

A rule to be followed in cutting the passage down to the required size is that only phrase-size units can be eliminated. The boundaries of the phrases in this passage are marked by diagonal slashes. Each of the phrases bounded by diagonal boundaries must either be kept entirely or eliminated entirely.

To be considered as legitimate data your abbreviated textbook passage must be within plus or minus five words of the number written in red.

It is vital, therefore, that your word-counts be accurate. Since it is so easy to err, it is suggested that the final count be done at least twice - one forward count and one backward count.

The title is not to be included in your count. Contractions count as two words.

If you cross-out a phrase and later decide to keep it, draw a circle around the crossed-out phrase and write "keep" within that circle.

To help you in your word counts, the number of words in each phrase unit is indicated in the margin to the right of each unit. If a phrase unit occupies two lines, its word count is on the line which has the bulk of the unit.

Before starting the job of eliminating phrases, read the entire passage. Then start by eliminating the least meaningful phrases first.

Phrases in textual passages differ in their meaningfulness levels, i.e., in the ease with which the phrases can be apprehended or understood. Such differences in difficulty are particularly evident during the early readings of a textual excerpt. These differences in meaningfulness undoubtedly result from many variables, but several factors are particularly important.

First, phrases differ in the extent to which the content of the phrase can be represented concretely. Abstract phrases refer to phrases containing concepts which do not have ready reference to concrete, tangible objects or events. As an example, think of the phrase "six broken bottles with jagged edges." Such a phrase refers to specific concrete objects and would be rated as highly meaningful. In contrast, the phrase stating that the "fundamental principles of truth contradict the facts of the issue" does not refer to concret objects and would be rated as highly abstract and low in meaningfulness. Linguistic phrases in which there are specific references to particular persons, places, or things thus should be judged as more meaningful than phrases in which the content is more general or abstract.

Linguistic phrases also differ in their capacities to arouse mental images of things or events. The more meaningful phrases arouse one or more sensory experiences, such as mental pictures, very quickly and easily, whereas the less meaningful phrases may do so only with difficulty (that is, after a long delay) or not at all. Think of the phrase "the wounded fox was relentlessly pursued by the barking hounds." Such a phrase would probably arouse imagery relatively easily and would be rated high in meaningfulness. In contrast, the amount of imagery for the phrase "the contemporary influence had not been anticipated previously" would not be great, and the phrase would receive a lower rating on meaningfulness. For the phrases in which some of the words evoke imagery and others do not, it will be necessary to make an averaging judgment as to the overall capacity of the whole phrase in evoking imagery. For <u>some</u> phrases, a single word in that phrase might be capable of evoking sufficient imagery that the entire phrase could be judged as being high in imagery and meaningfulness. For other phrases, the presence of only one imagery-producing word still might not be sufficient to result in the phrase being rated as high in imagery. In short, the phrases need to be judged partially on the basis of the imagery-evoking properties of the phrase as a whole.

Thirdly, the meaningfulness of the phrase also depends upon the extent to which the various words are common or familiar. To say that a task was "odious" would be less common than describing the task as being "very unpleasant." Phrases which contain familiar words are usually more meaningful than phrases containing words which are seldom used.

Finally, phrases which are meaningful are more likely to call forth many associations with one's past experiences. The phrase "in the course of reading books, I found that . . ." is probably more likely to evoke a variety of associations than is the phrase "in the course of buying a new pencil, I found that . . ." Of the various characteristics of meaningfulness that we have mentioned, the ease with which the linguistic phrase can be related to your previous experiences should be the most important determinant of your ratings of meaningfulness.

In making global ratings of the meaningfulness of the phrases, it may be helpful to ask four questions about each of the phrases.

(1) Does the phrase refer to concrete and specific content rather than abstract or general content?

(2) Does the phrase readily arouse sensory imagery?

(3) Are the words in the phrase familiar and easy to understand, or are the words unusual?

(4) Does the phrase readily call forth associations with various past experiences?

If the phrase reminds you of things or content that you already know, if the phrase is high in concreteness or imagery, and if the phrase is composed of familiar words, the verbal unit should be rated as being high in meaningfulness.

Here are some other suggestions to aid you in making ratings. One of the difficulties noted by raters in a pilot study was that almost all of the phrases could be comprehended without too much trouble, that is, with a little effort, all of the phrases made sense. If you have a similar difficulty while making your ratings, it may be helpful to read a portion of the passage at a speed somewhat faster than your normal reading rate. The phrases which are less readily comprehended at the faster rate should probably be judged as being lower in meaningfulness.

A technique which has been successful with some raters is to make judgments as to how comprehensible the phrases would be to students who were younger than themselves, or to students who were less intelligent than themselves.

Another problem which has given raters difficulty is the question of what to do with phrases which are very familiar, perhaps even being cliches. These kinds of phrases make sense and are easily

comprehended, but are somewhat empty in that the phrases do not evoke much imagery and seem to be used by authors mainly as connectives or fillers. These stereotyped phrases should ordinarily be rated as low in meaningfulness.

Similarly, in textual prose, authors often include phrases which perform the function of establishing the temporal sequence of events. Examples of such phrases are "to continue with the next step," "at this point," "in the final phase of the experiment," and "after approximately one-half hour has passed." For these phrases, it is important to ask whether they refer to concrete events, and whether they evoke imagery and associations. Some of these phrases may be meaningful in the context of the verbal passage, while other phrases of this type may simply be connective words which possess little meaning.

Some raters have encountered difficulty from the fact that the boundaries of the phrases do not always come at the beginnings or ends of sentences. These raters are reluctant to eliminate a portion of a sentence because, they say, the rest of the sentence does not make sense when a portion has been eliminated. Their comments are absolutely correct, but this concern should not influence your ratings of meaningfulness. If, for example, a sentence is composed of two or more phrase-defined units, and only one of these units is meaningful, only the less meaningful units should be eliminated. Thus, the phrases which are allowed to remain in your passage may be quite meaningful when judged individually, and yet these same phrases will not make much sense when read together as if they were a single package.

Similarly, a unit should not be judged to be meaningful simply because the content of the unit is vital to the textual passage. The rater's job is not to judge the importance of the phrase unit; instead the rater's job is to judge the meaningfulness of each unit. Some of the important units are not necessarily meaningful. As an illustration, phrases which are generalizations or principles might be judged to be important, and yet these same phrases might be judged to be less meaningful because the content is largely abstract. Likewise, some of the units which are meaningful are not necessarily important. Phrase units which are examples or illustrations of generalizations may be judged to be highly meaningful because their content is quite concrete. Such illustrations, however, are less important than the generalizations themselves.

Appendix I

Rating Information - Judgments of Predicted

Recall of Phrases from Textual

Excerpts

General Background. - In various experiments, students were told to learn one of the attached textbook excerpts by reading the passage twice at their normal rate of reading. Before beginning their learning efforts, the students were told that sometime in the future they would be tested on the accuracy of their recall. Some of the students were required to reporduce the passage immediately after their learning session, whereas other students attempted recall after a delayed retention interval. The students were told to recall the linguistic passage in as much detail as possible and as exactly as possible. In actuality, however, the reproductions were scored very leniently. Credit for remembering a phrase was given if <u>any</u> portion of the linguistic phrase was recalled. Credit was allowed also if the rater could detect <u>any</u> evidence that the original linguistic phrase was having <u>any</u> influence upon the learner's reproduction of the textual excerpt.

For the present ratings, imagine that you had actually been a participant in that experiment. Your task is to make predictions of the relative ease with which you would have been able to learn or remember the various phrases or sentences in the textual excerpts.

The actual procedure that is to be followed is to cross-out the phrase units which would be the least likely to be recalled or remembered until you have reduced the words in the textual passage to the number in red ink in the upper right-hand corner of your copy. For example, if the number in red ink on the textual excerpt called "Evolution of the Brain" is 405, your task is to eliminate the 405 words which you would predict would be the least likely units to be remembered in the 810 word textual passage. If your number in red ink is 608, you are to eliminate 202 words. If your number in red ink is 202, you should eliminate 608 words.

In the selection called "The Role of Language in Learning," if the number in red ink is 325, your task is to eliminate the 325 words which would be the least likely to be recalled in the 650-word passage. If your number in red ink is 487, you are to eliminate 163 words. If your number in red ink is 163, you should eliminate 487 words.

A rule to be followed in cutting the passage down to the required size is that only phrase-size units can be eliminated. The boundaries of the phrases in this passage are marked by diagonal slashes. Each of the phrases bounded by diagonal boundaries must either be kept entirely or eliminated entirely.

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It is vital, therefore, that your word-counts be accurate. Since it is so easy to err, it is suggested that the final count be done at least twice - once forward count and one backward count.

The title is not to be included in your count. Contractions count as two words.

If you cross-out a phrase and later decide to keep it, draw a circle around the crossed-out phrase and write "keep" within that circle.

To help you in your word counts, the number of words in each phrase unit is indicated in the margin to the right of each unit. If a phrase unit occupies two lines, its word count is on the line which has the bulk of the unit.

Before starting the job of eliminating phrases, read the entire passage. Then start by eliminating the phrases which you think you would be least likely to remember.

Some raters have encountered difficulty from the fact that the boundaries of the phrases do not always come at the beginnings or ends of sentences. These raters are reluctant to eliminate a portion of a sentence because, they say, the rest of the sentence does not make sense when a portion has been eliminated. Their comments are absolutely correct, but this concern should not influence your ratings. As much as it is possible, try to rate each phrase unit without being concerned about whether the phrase unit could stand alone.